



California Climate Change Conference 9/14/2006

Climate Change Scenarios Assessment

Some Lessons for California

Dan Cayan

Climate Research Division

Scripps Institution of Oceanography, SIO/UCSD

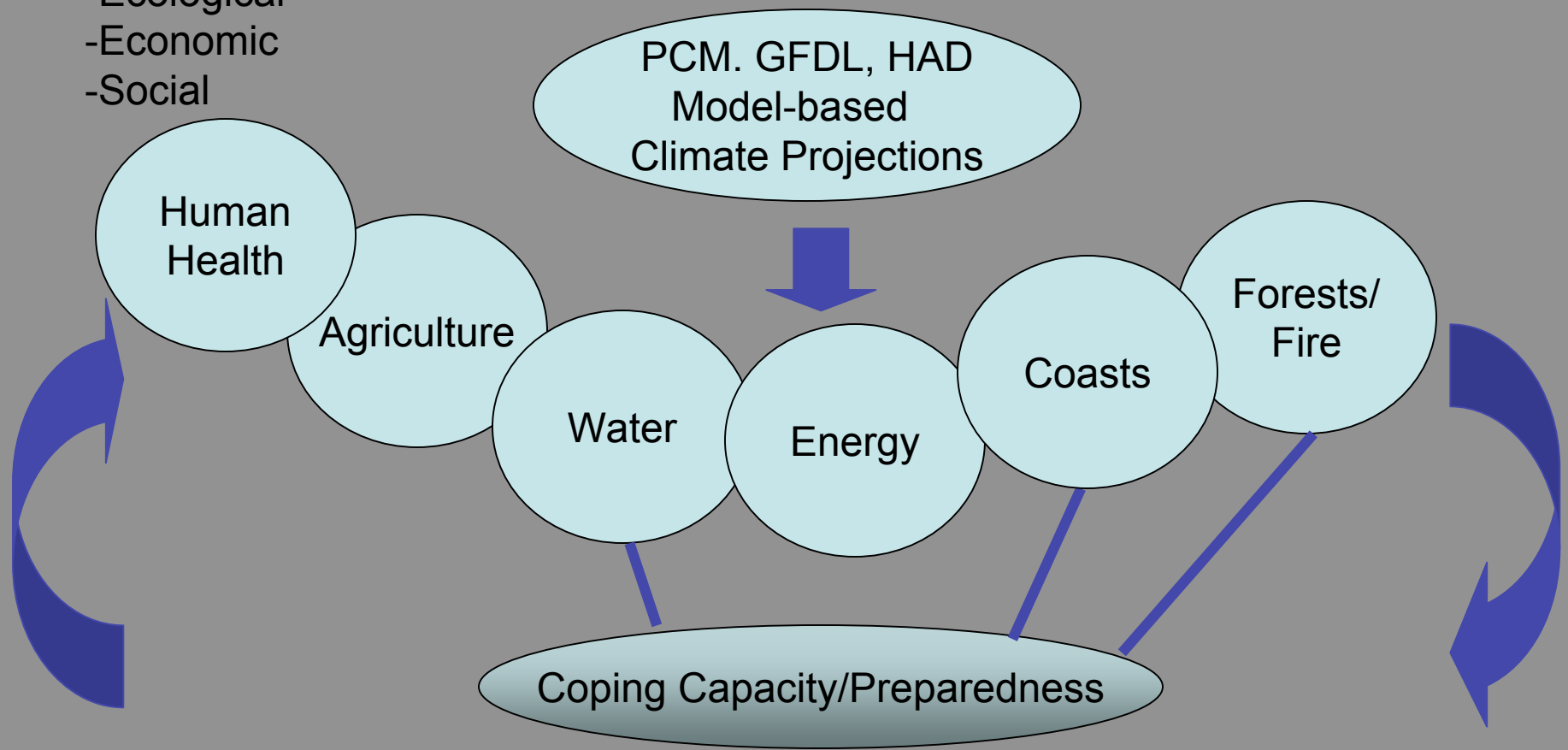
and, many others!

How will Climate Change Impact California?

Impacts

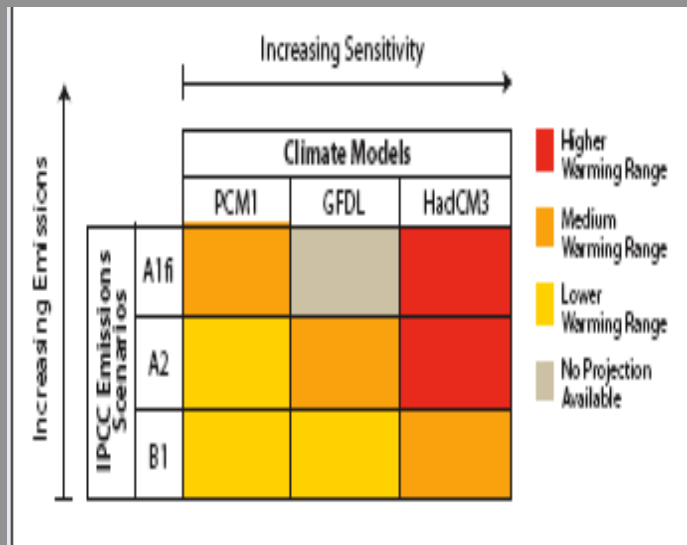
- Physical
- Ecological
- Economic
- Social

Scenarios, not forecasts



Simulations in Scenarios Assessment span range of GHG emissions, climate sensitivity

Across virtually all sectors, impacts intensify as warming increases



Summary of Impacts (end of century)

Scenarios*	Summary of Projected Global Warming Impact, 2070 to 2099 (as compared with 1961–1990)	Statewide Temperature Rise
Higher Emissions: Rapid, fossil-fuel intensive growth	<ul style="list-style-type: none"> 90% loss in Sierra snowpack 22–30 inches of sea level rise 3–4 times as many heat wave days in major urban centers 4–6 times as many heat-related deaths for major urban centers 2.5 times more critically dry years 20% increase in energy demand 	Higher Warming Range: 8–10.5°F
Medium-High Emissions: Primarily fossil-fuel dependent growth with improvements in energy efficiency	<ul style="list-style-type: none"> 70–80% loss in Sierra snowpack 14–22 inches of sea level rise 2.5–4 times as many heat wave days in major urban centers 2–6 times as many heat-related deaths in major urban centers 75–85% increase in days conducive to ozone formation 2–2.5 times more critically dry years 10% increase in electricity demand 30% decrease in forest yields (pine) 55% increase in the expected risk of large wildfires 	Medium Warming Range: 5.5–8°F
Lower Emissions: Less fossil-fuel dependent growth with heavy investment in cleaner technologies	<ul style="list-style-type: none"> 30–60% loss in Sierra snowpack 6–14 inches of sea level rise 2–2.5 times as many heat wave days in major urban centers 2–3 times as many heat-related deaths for major urban centers 25–35% increase in days conducive to ozone formation Up to 1.5 times more critically dry years 3–6% increase in electricity demand 7–14% decrease in forest yields (pine) 10–35% increase in the risk of large wildfires 	Lower Warming Range: 3.0–5.5°F

IPCC GHG Emissions Scenarios

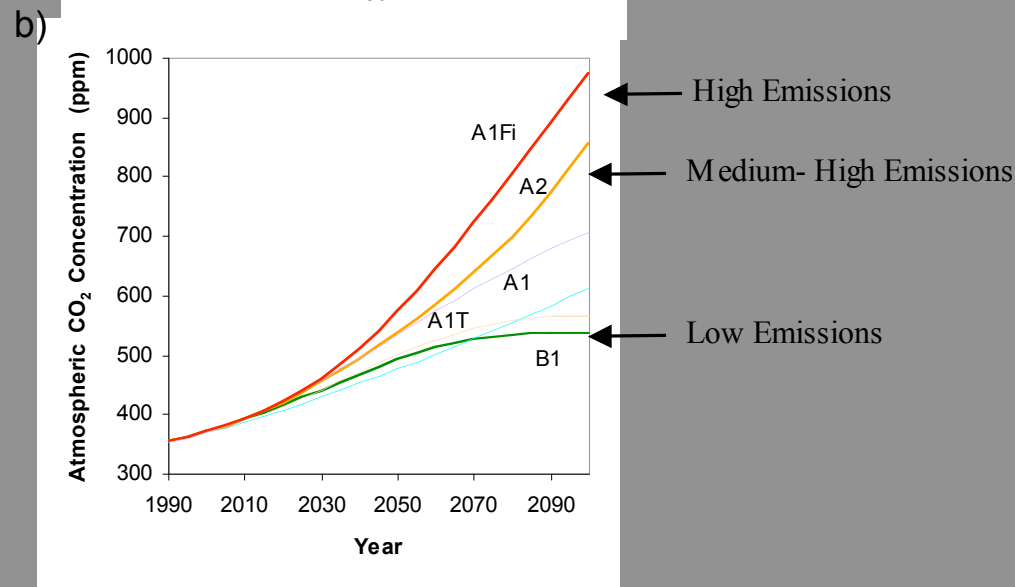
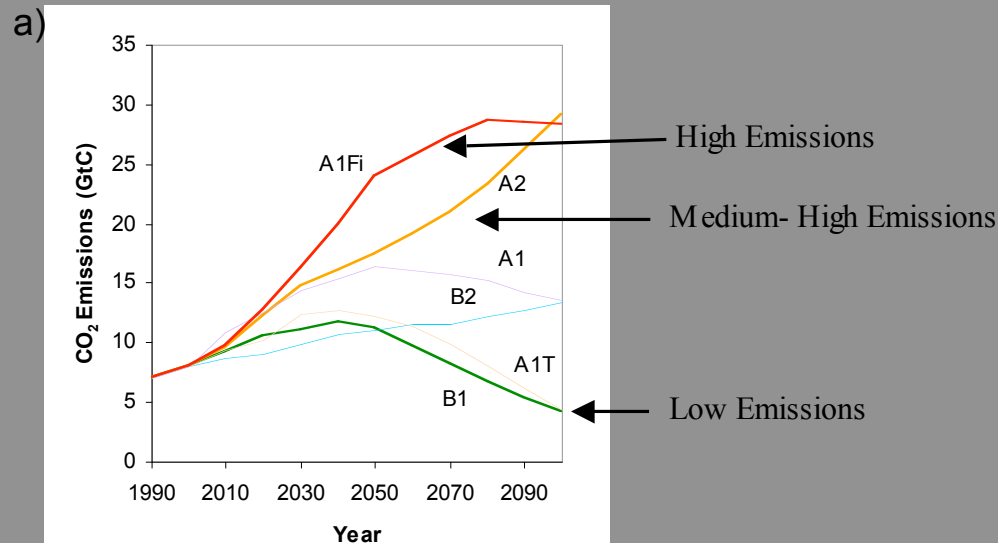
range from low to high

scenarios depend on a global set of economies, populations, technologies, decisions, etc

CO₂ is most important anthropogenic GHG

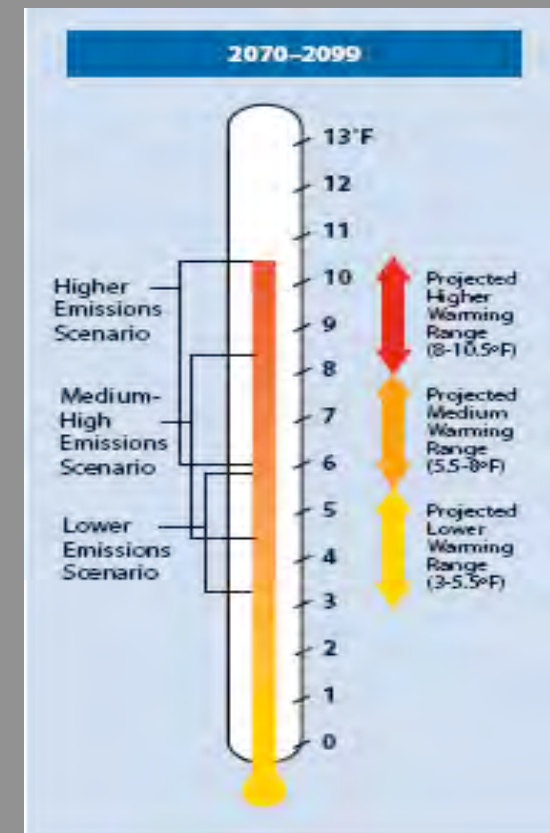
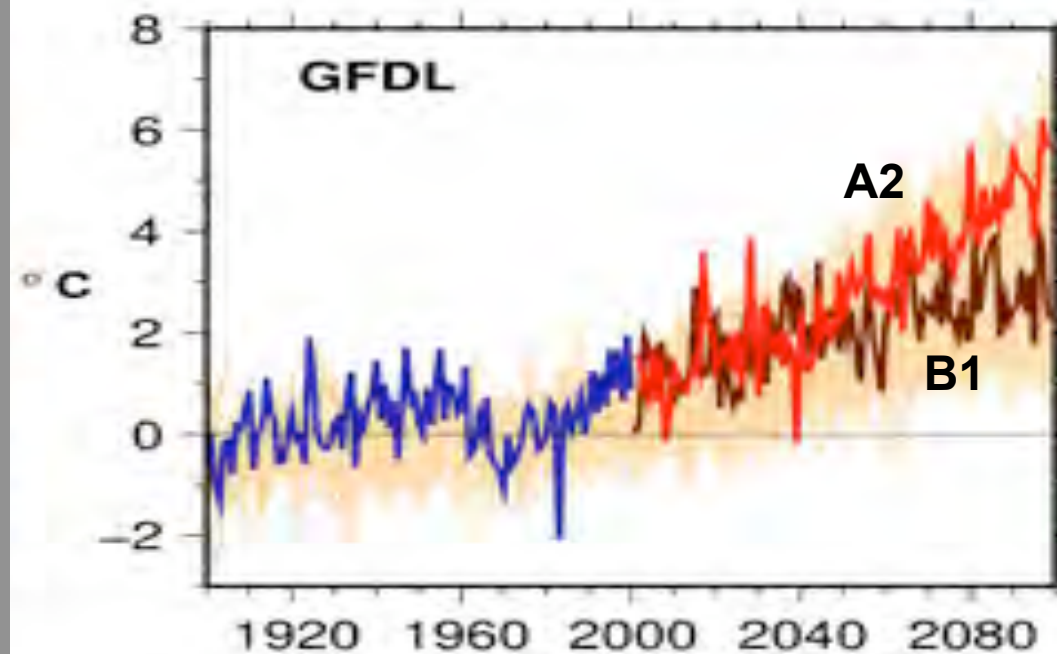
CO₂ and other GHG's have long Residence times in atmosphere—emissions today accumulate, so will be felt by following generations

Even low scenarios double the concentration of atmospheric CO₂. Under high scenarios, CO₂ concentration would triple by 2100

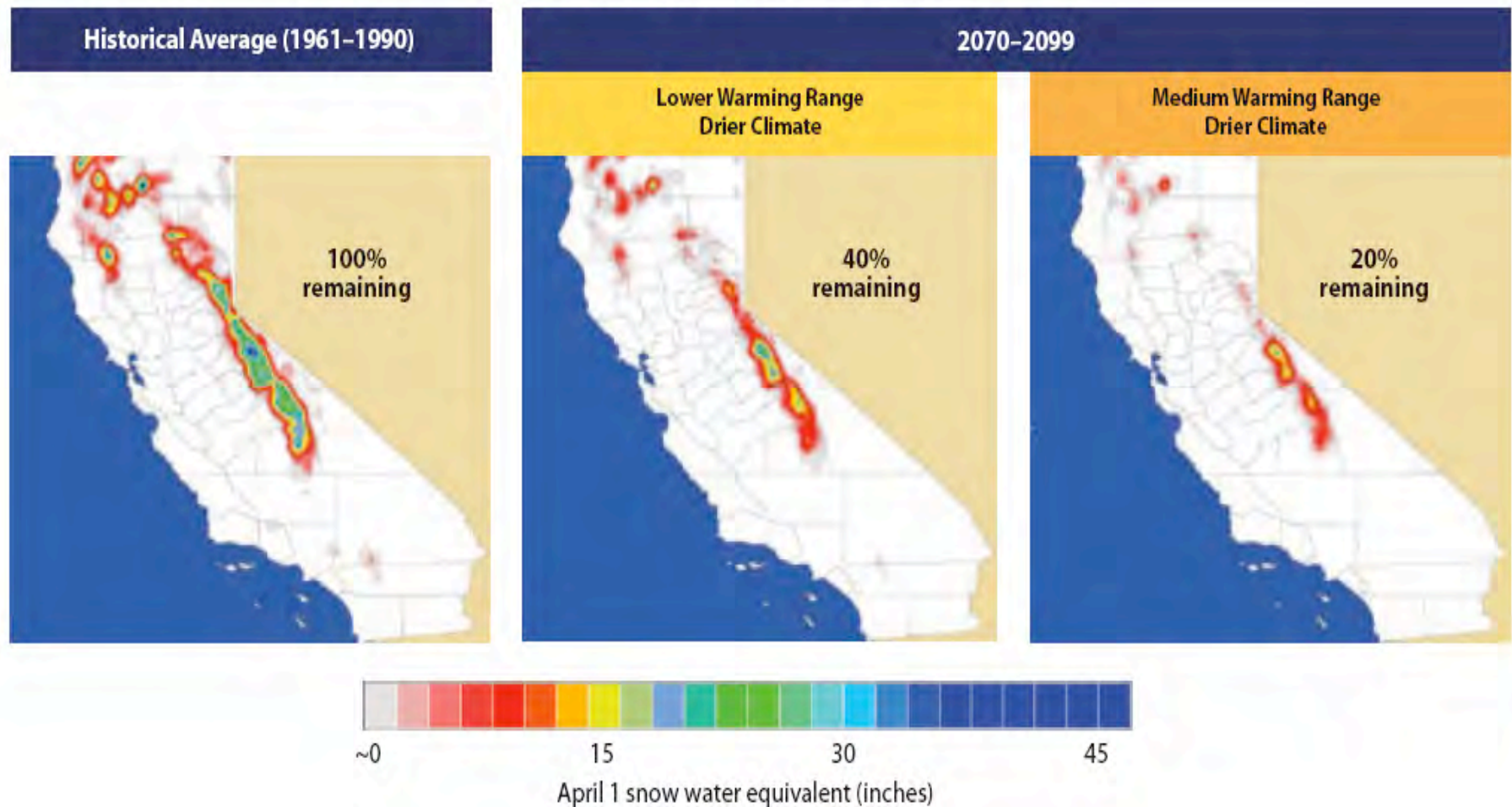


strong consensus for warming
higher vs. lower scenarios diverge ~2050
different models of climate sensitivity

SRESB1 sfc air temp anom
IPCC4 AR4 models, 3 scenarios)
-90 climatology)



Decreasing California Snowpack

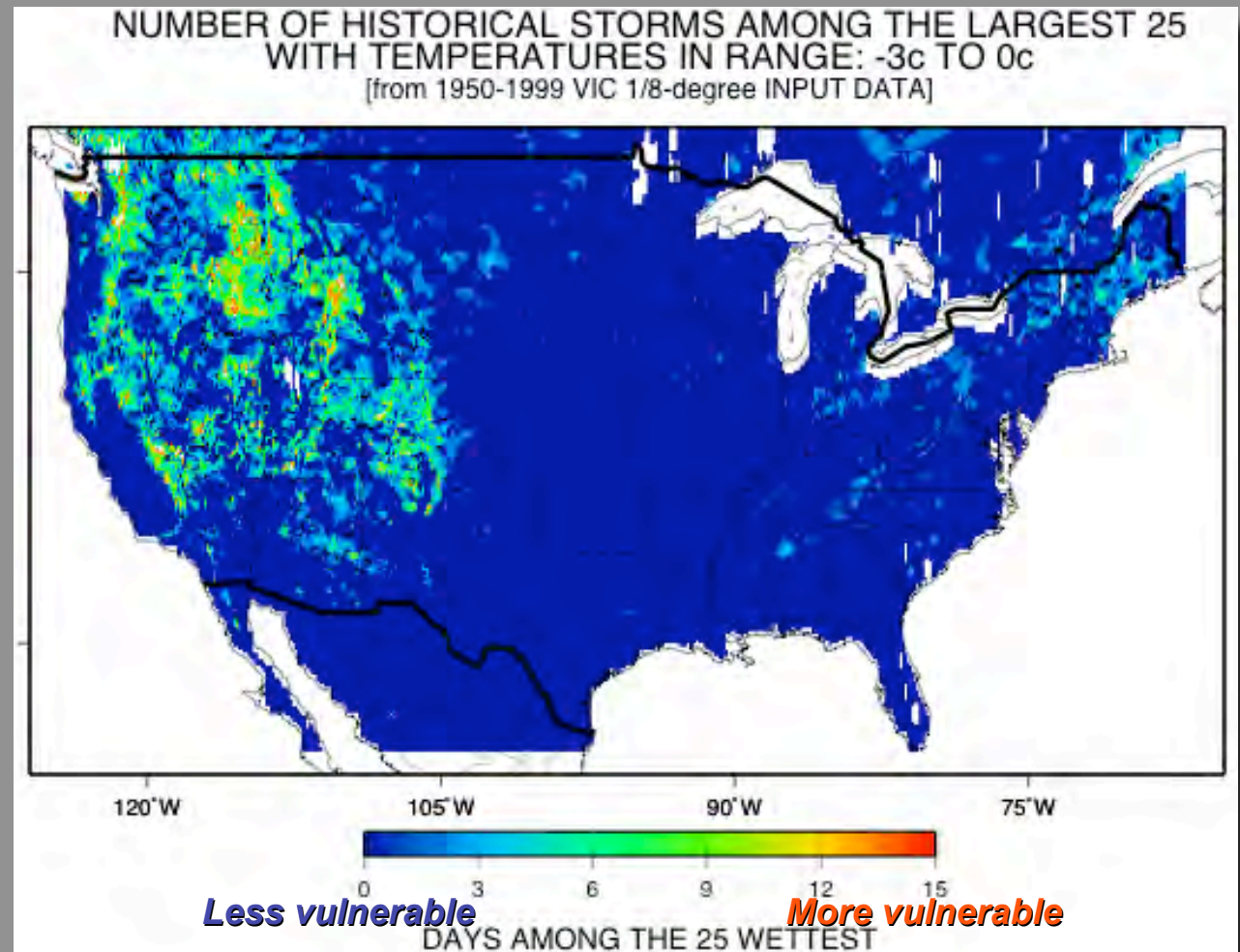


Critical differences - lower vs higher GHG emissions
and, *uneven* snow loss from climate warming

How many of the largest historical storms were just below freezing?

Because of this topography and its regularly near-freezing temps, parts of watersheds on the west slope of the Sierra such as Yosemite are among the areas most highly vulnerable to warming in the Nation:
in this case, to possible warming-induced flooding

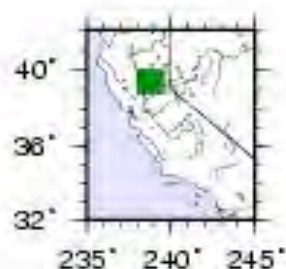
Computed from gridded historical US weather data (from Bates et al, in rev)



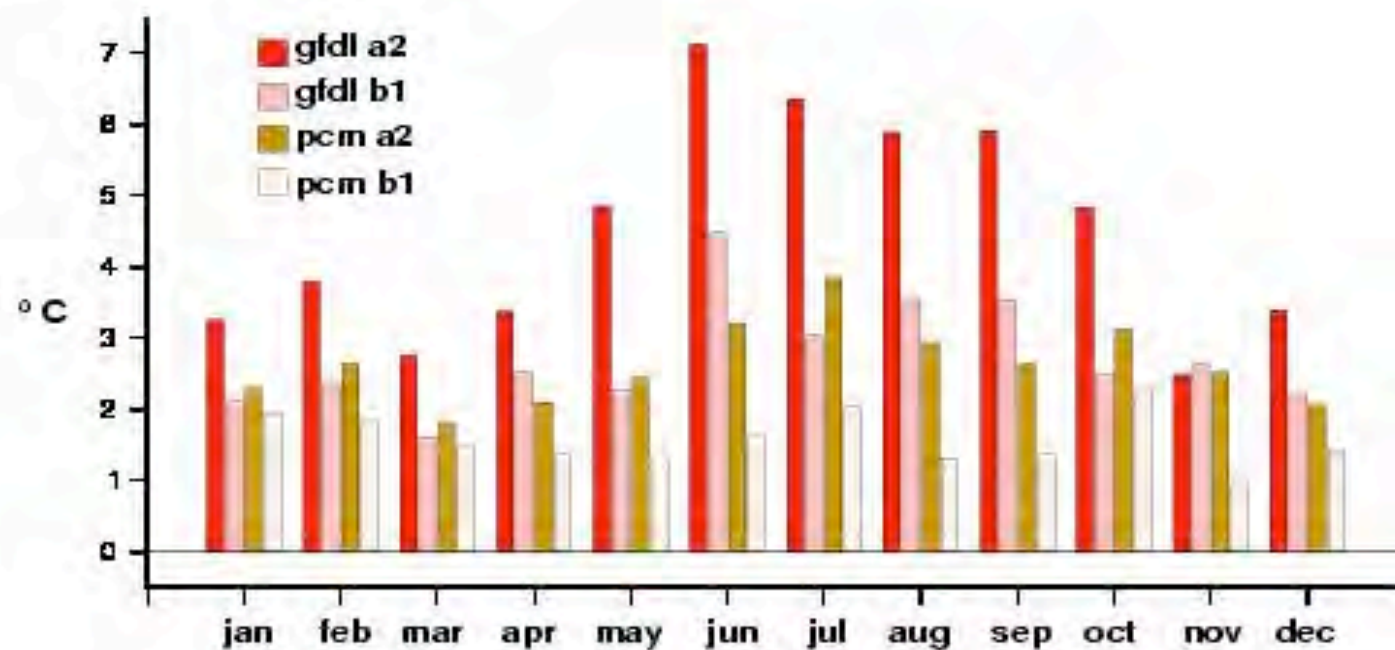
“Warm-storm flooding”

Seasonally intensified warming?

some models suggest amplified summer warming



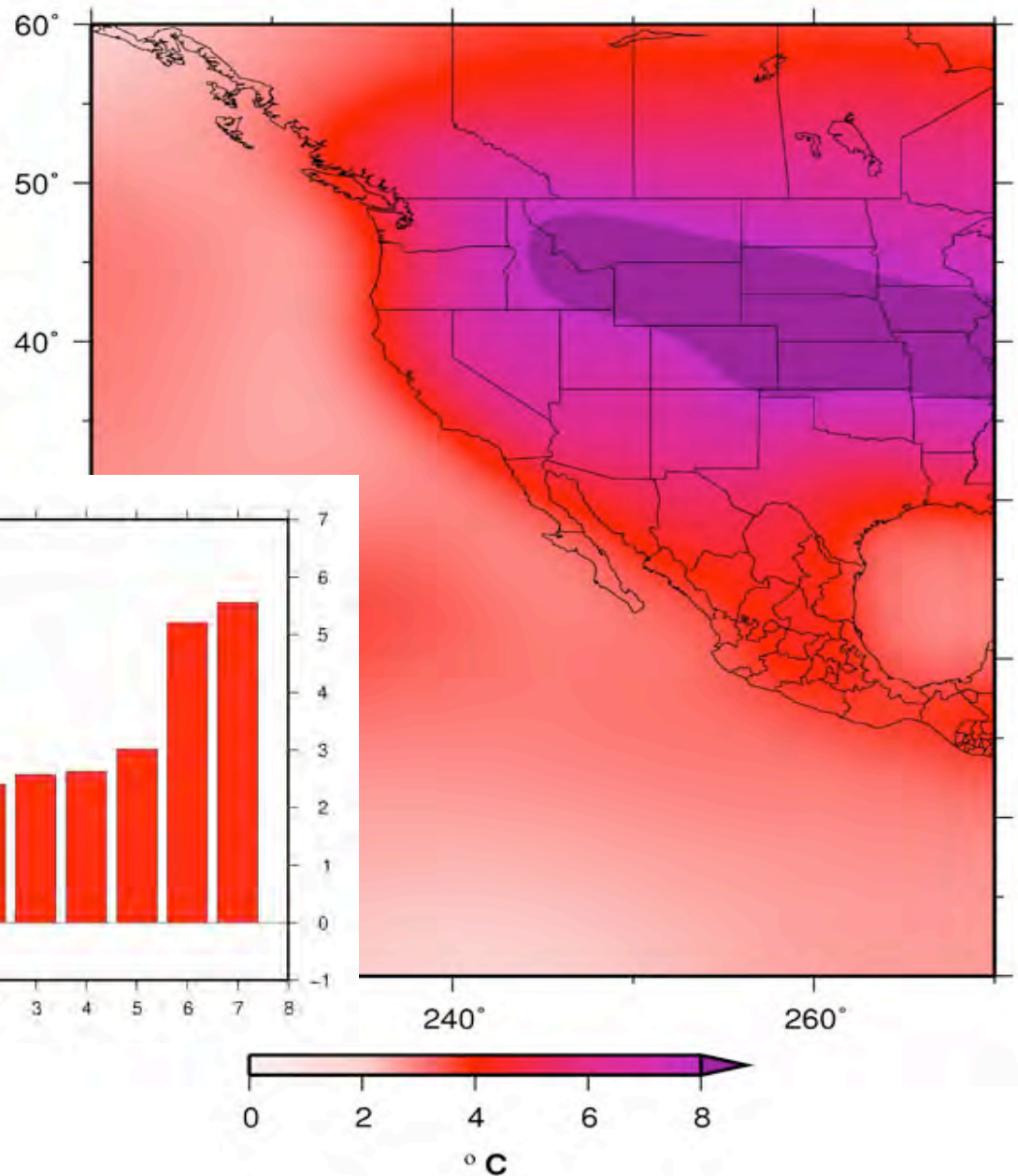
**Nocal temperature anomaly
2070–2099 minus 1970–1999**



Climate models project ocean warming by end of century of 1.5-2.C greater warming on land than oceans would amplify thermal gradient across California coast-interior

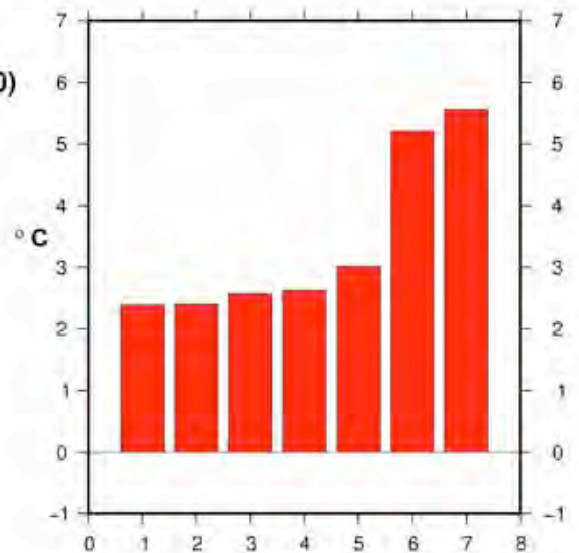
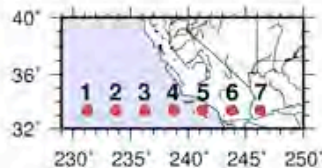
Summer land warming is accentuated

GFDL CM2.1 Jun-Aug air temp change
2070-2099 minus 1961-1990



sfc air temp difference
(2070-2099 minus 1961-1990)
sresa2 gfdl cm2.1
jja

southern calif transect



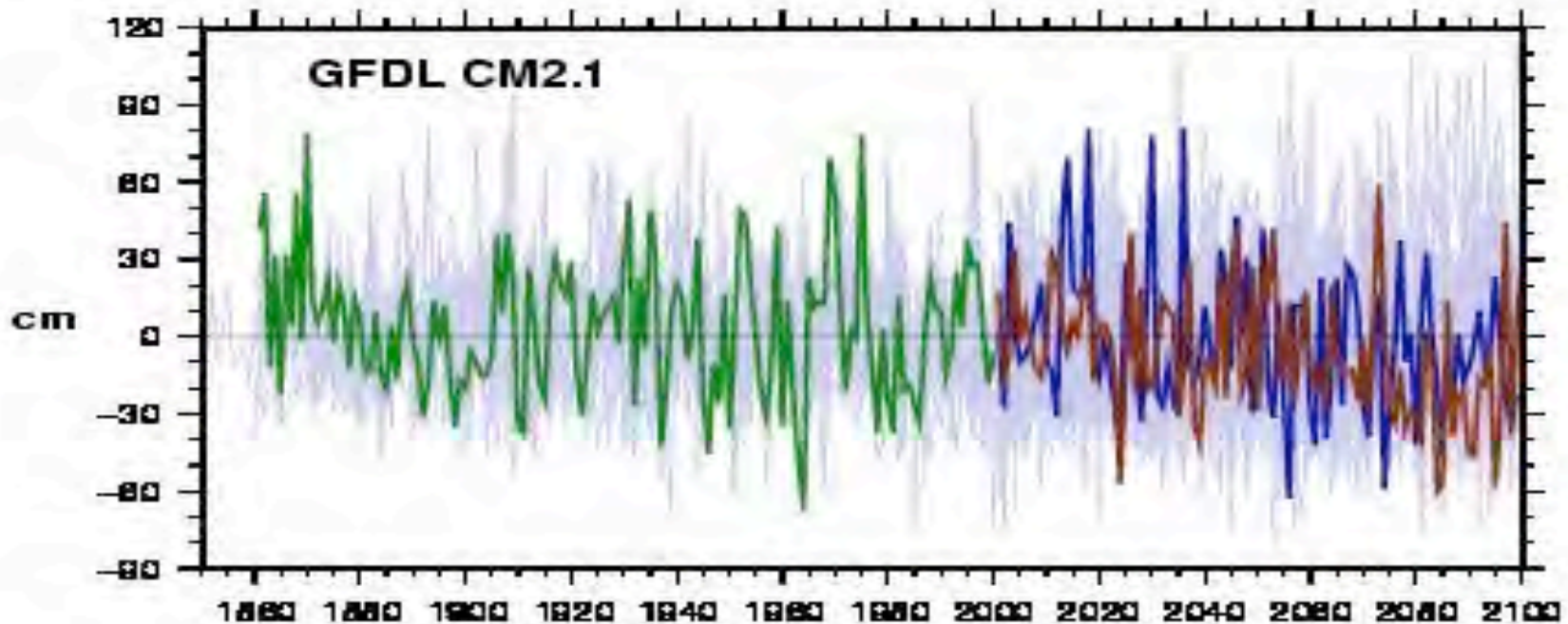
Will California receive adequate precipitation?

Little consensus wetter or drier

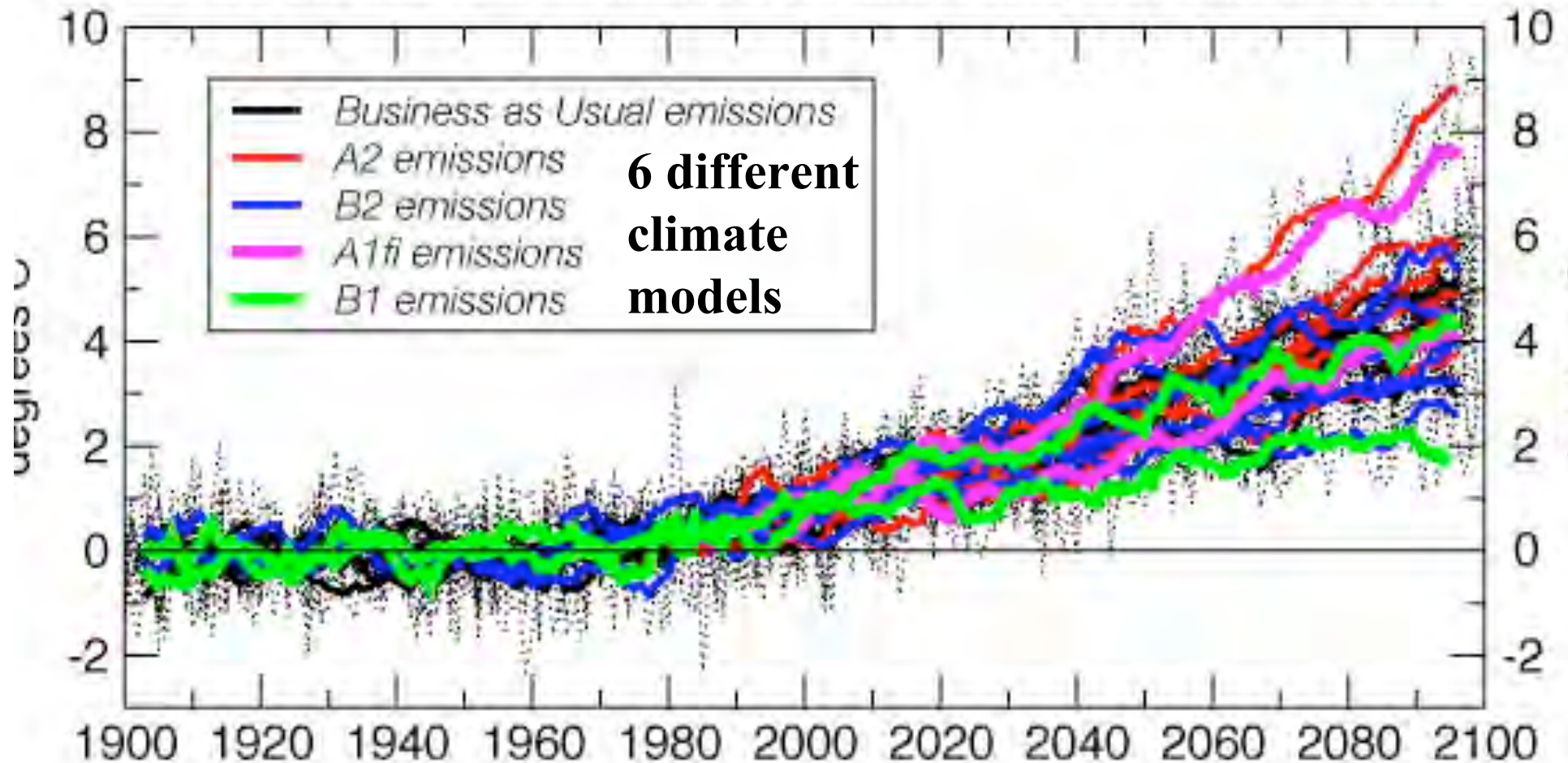
Considerable interannual-interdecadal variability

Not so much divergence between scenarios.

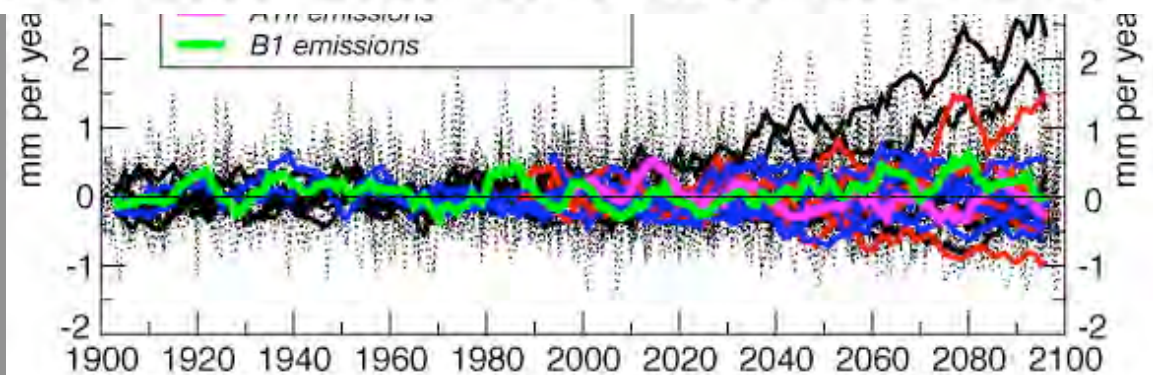
NoCal annual SRESA2 and SRESB1 precipitation anomalies
(background shows 13 IPCC4 AR4 models, 3 scenarios)
(1961–90 climatology)



PROJECTED CHANGES IN ANNUAL TEMPERATURE, NORTHERN CALIFORNIA

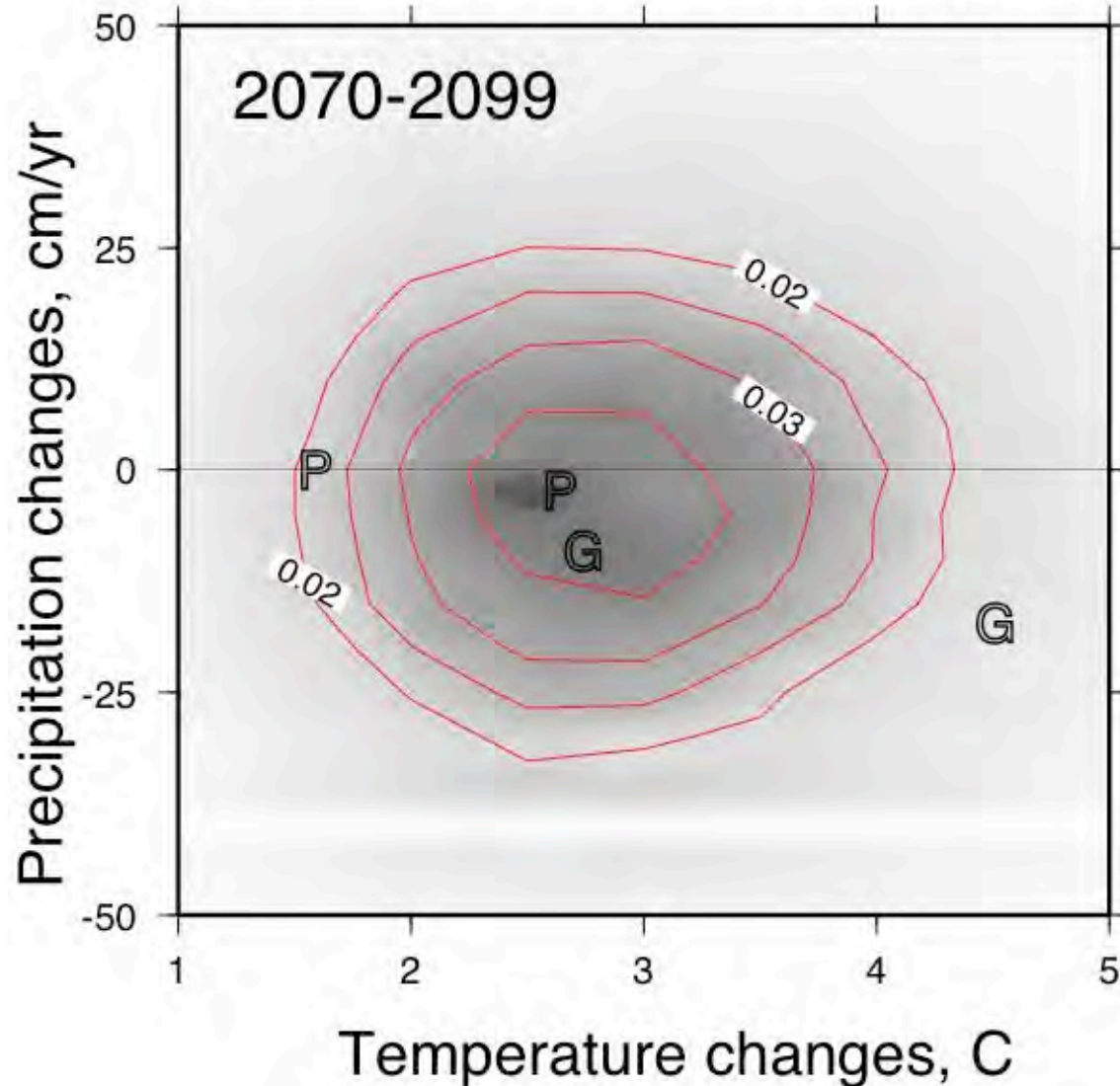


Strong consensus for warming
But large uncertainty about precipitation



JOINT PDF OF NORTHERN CALIFORNIA ANNUAL CLIMATE CHANGES

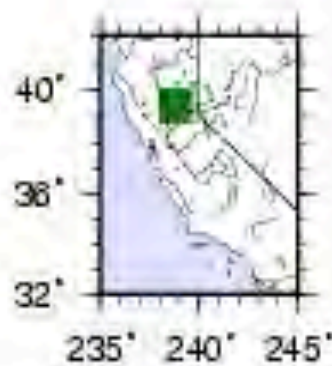
[Ensemble of 12 models under A1b, B1 and A2]



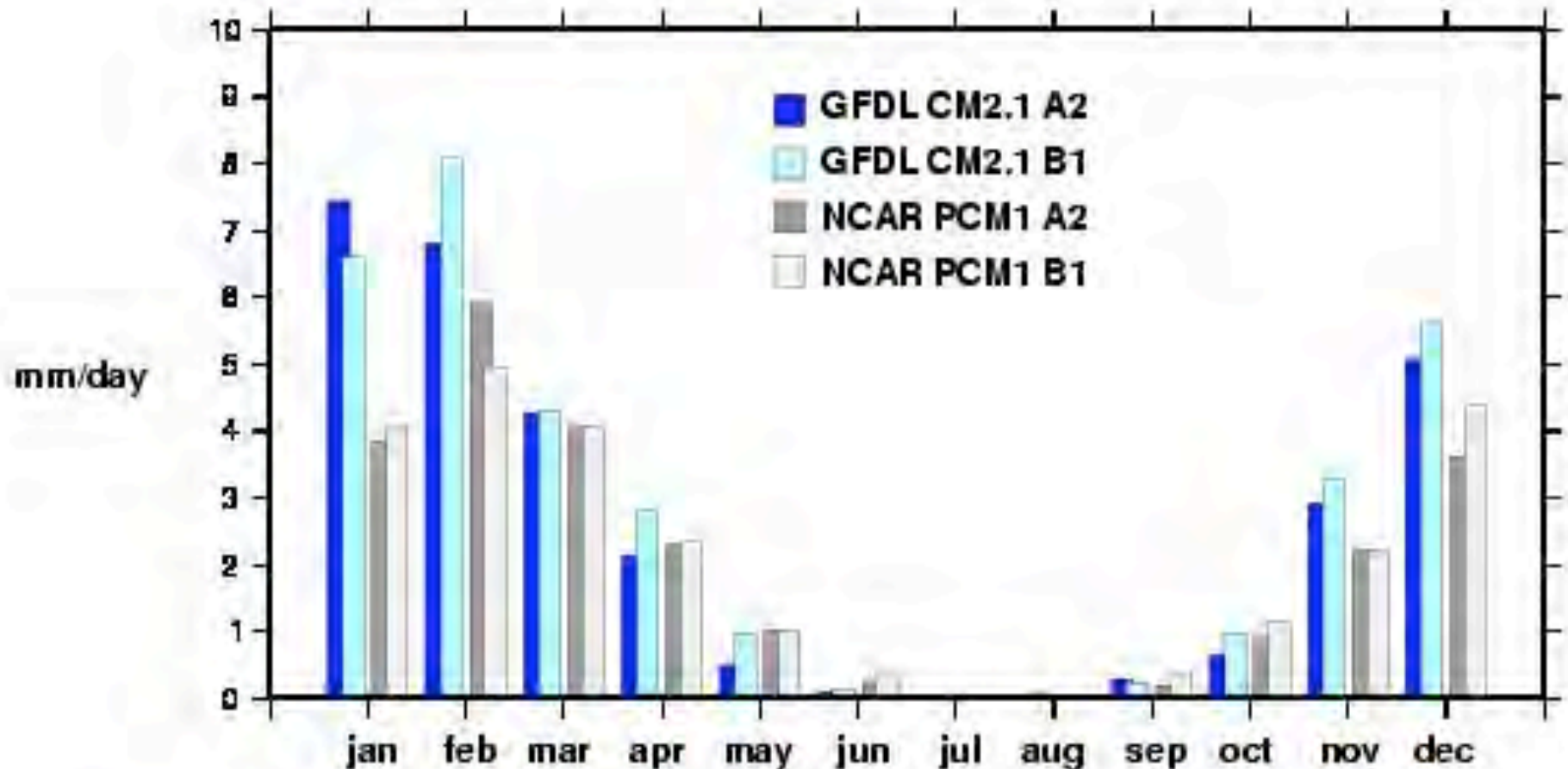
Across model simulations, projected temperature and precipitation changes span broad range and seem to be uncorrelated

Mike Dettinger, USGS

Mediterranean precipitation regime remains



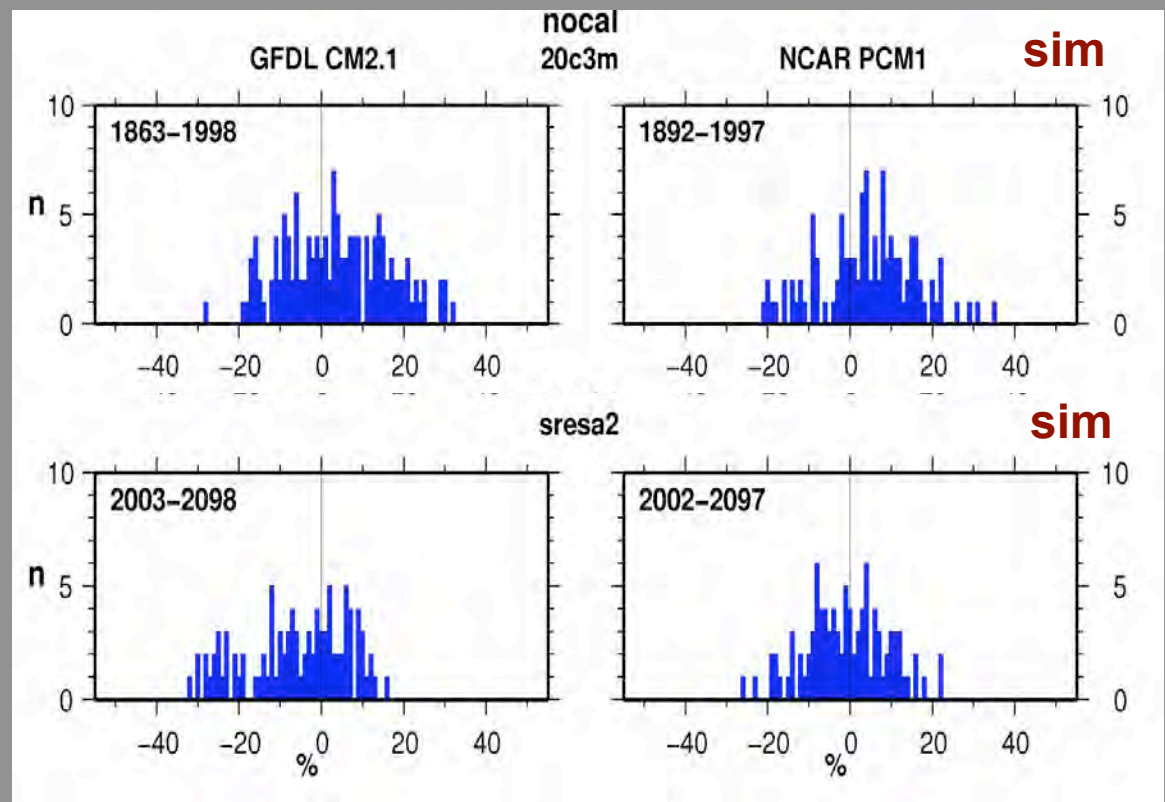
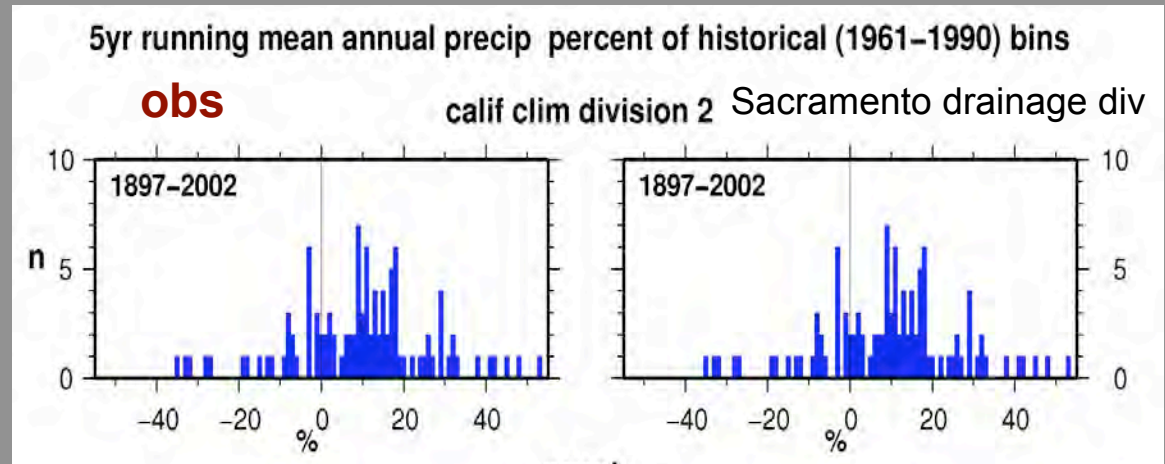
Nocal precipitation
climate projection 2070–2099



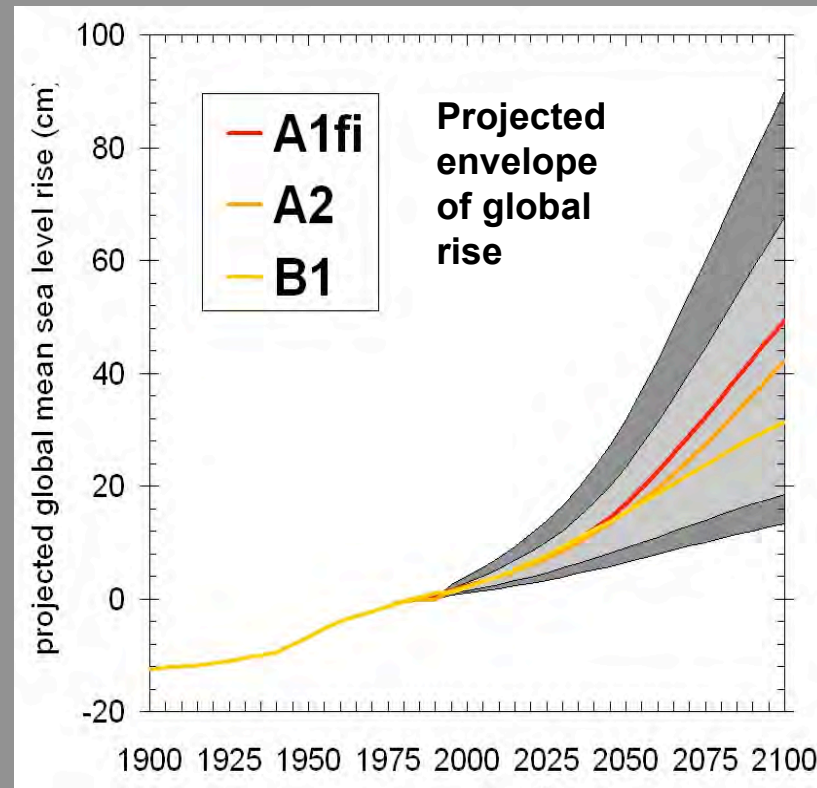
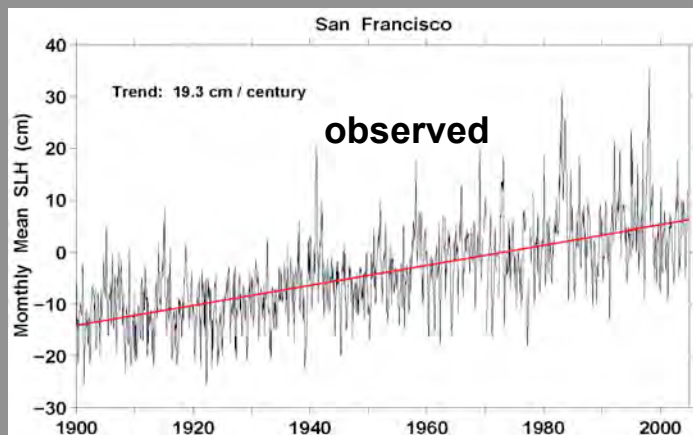
Are models
capable of
producing
realistic
suite of
wet and dry
spells?

Distribution of
Obs and simulated
5yr precip departures

Hist means (inches):
Div2 36.02
Gfdl 43.13
Pcm 29.63



As climate warms, sea level will rise more and faster but how fast/how much depends on temp change and other unknowns



Observed San Francisco (left) and model projected Global (right) sea level rise Models include envelope of output from several GCMs run under 3 different GHG emission scenarios

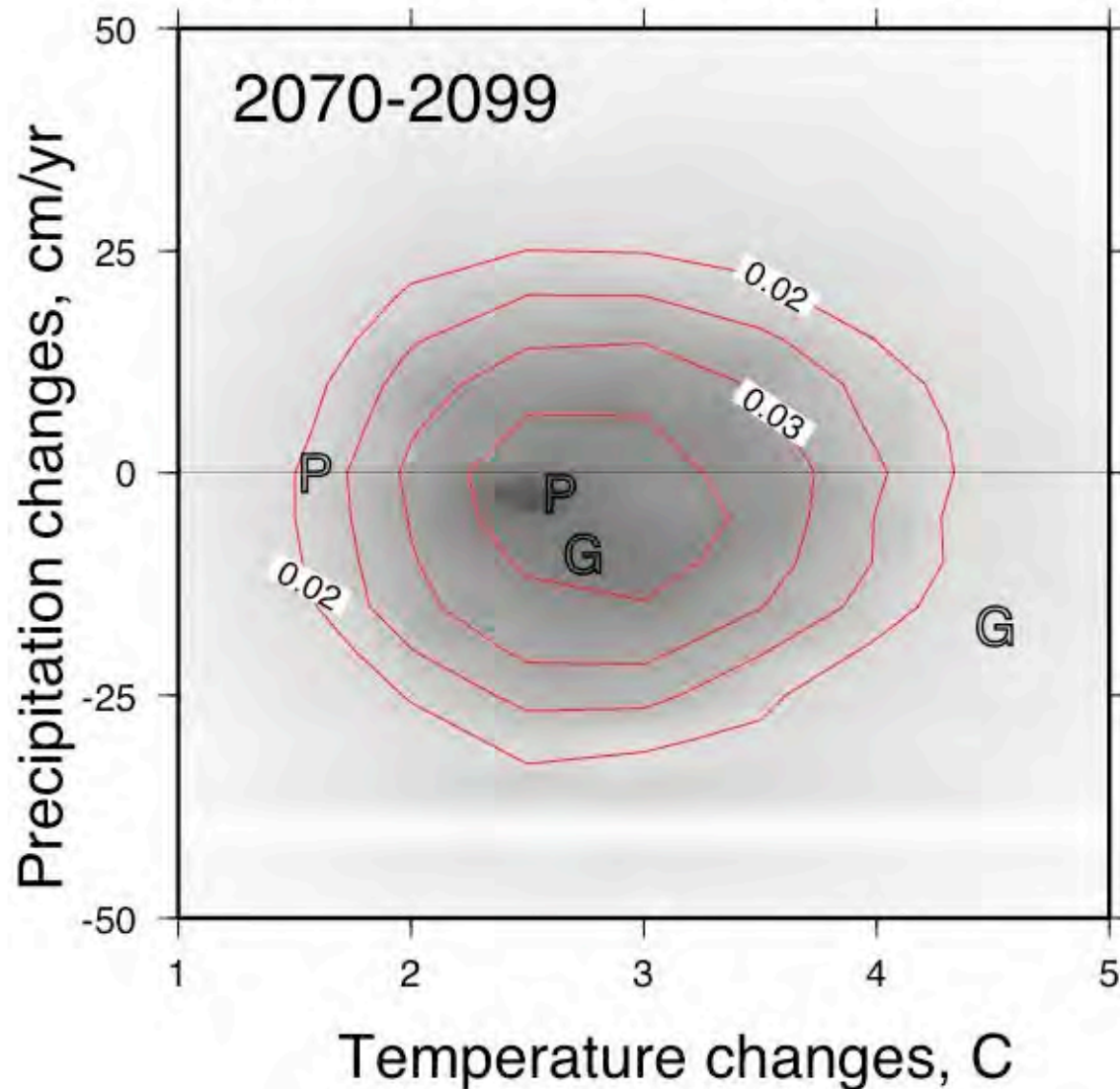
Ocean Beach, California , February 1983



**Coastal damage will occur when
Storm-forced sea levels during extreme tide and El Nino**

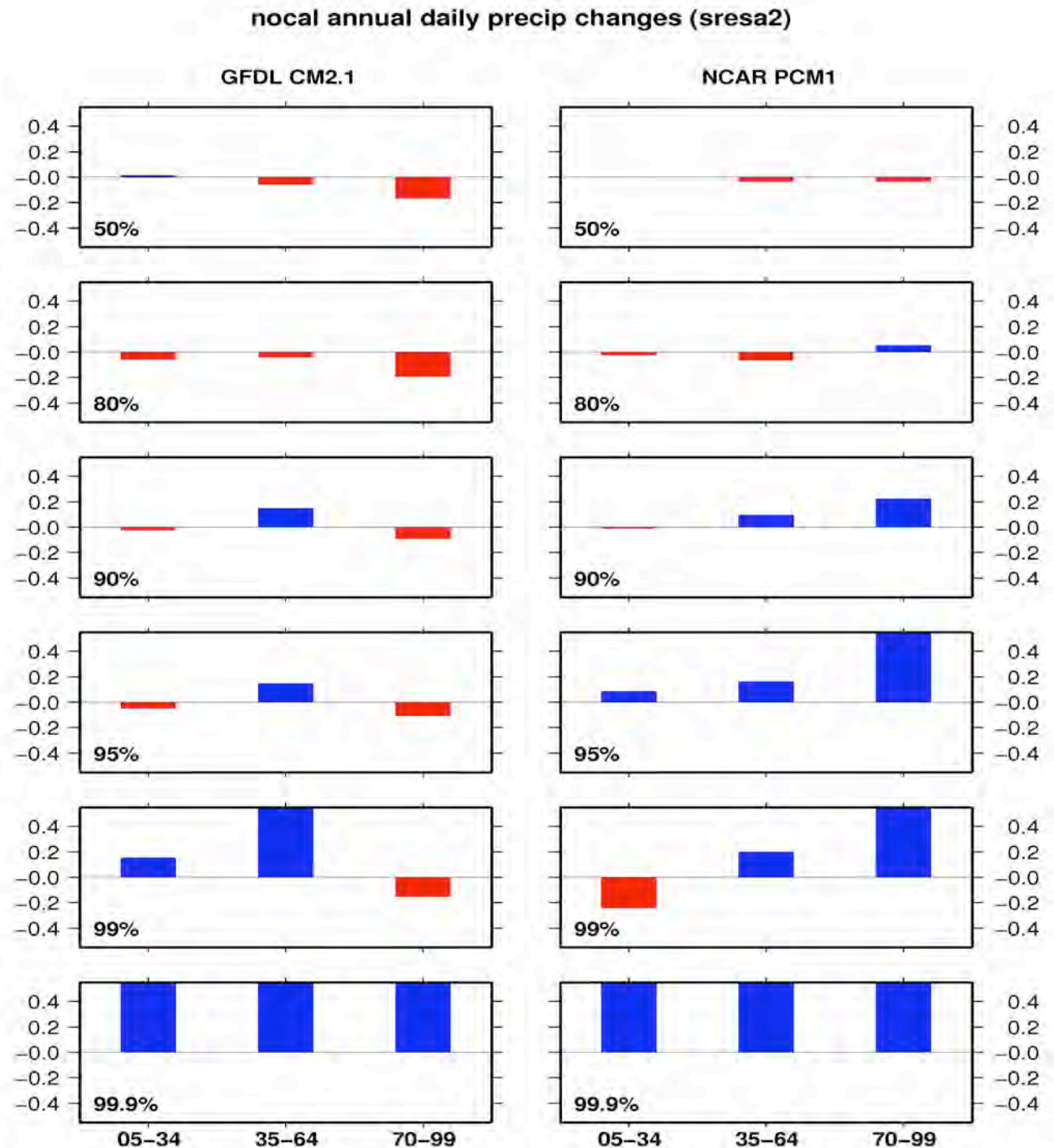
JOINT PDF OF NORTHERN CALIFORNIA ANNUAL CLIMATE CHANGES

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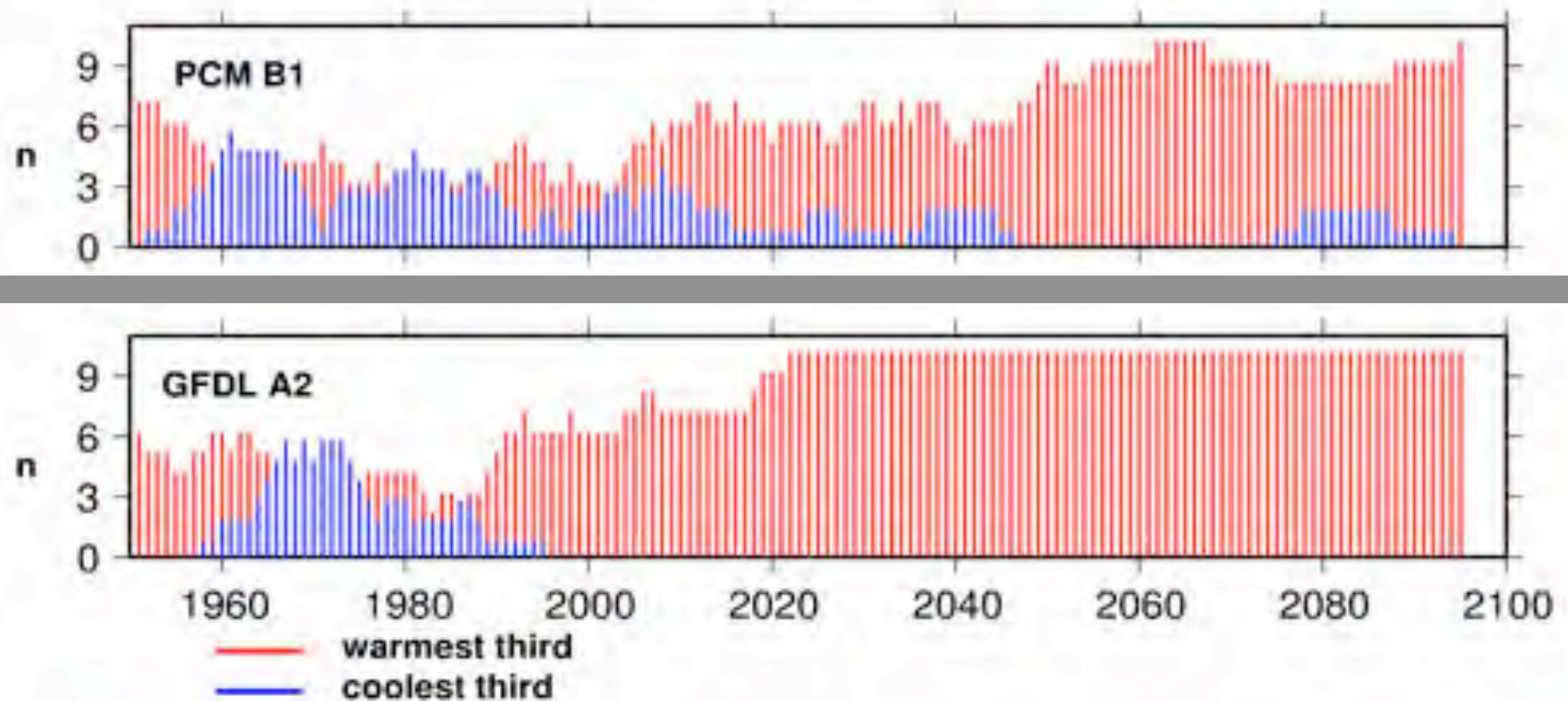
Model
Simulations
In scenarios
assessment
ranged
from moderate
to dry

Heavy precipitation events may become more frequent, even though mean precipitation declines.



The extinction of the cool part of the temperature distribution

nocal jja sfc air temp terciles
counts in sliding decades centered at years 1950 to 2095



concluding remarks:

**Important to study projections from a range of simulations
to explore possible, but uncertain future**

**California's setting, ecosystems, social systems responds
uniquely to climate change**

**We still lack spatial detail—
how will California's meso and micro-climates respond?**

**Secular changes will accentuate higher frequency events
natural variability matters!**

**Sector impacts--
exploration has only begun
models and data may not be adequate**

